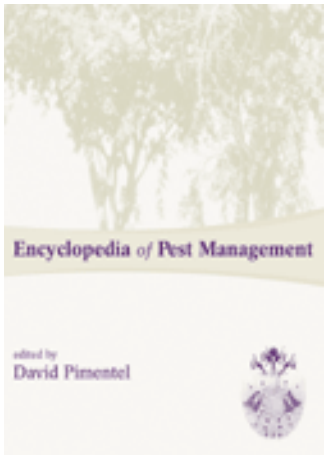

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Pear Insects: Ecology and Control

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Pear Insects: Ecology and Control

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Abstract

Over 15 million metric tons of pears were produced worldwide in 2004, of which China, the United States, and Italy produced about 60%, 6%, and 5%, respectively, of the total. In the United States, pears are grown commercially in nine states, with three western states (Washington, Oregon, and California) accounting for more than 90% of the pear acreage.

INTRODUCTION

Over 15 million metric tons of pears were produced worldwide in 2004, of which China, the United States, and Italy produced about 60%, 6%, and 5%, respectively, of the total.[1] In the United States, pears are grown commercially in nine states, with three western states (Washington, Oregon, and California) accounting for more than 90% of the pear acreage.[2]

Pears are attacked by a number of arthropod pests that reduce grower return either by directly damaging the fruit or by reducing yield. This suite of pests includes two primary taxa, codling moth (*Cydia pomonella*) and the pear psyllids (*Cacopyslla* spp.), and other secondary pests distributed among several orders (see Table 1). This entry will briefly summarize the biology of the primary arthropods attacking pears, with emphasis on the North American and western European faunas. The discussion of biology will be followed by an overview of control approaches, with sections on insecticide programs, mating disruption, and biological control.

PEST ARTHROPODS

Codling moth (*Cydia pomonella*) is the most serious pest of pome fruits in the temperate fruit growing regions of the world except in Japan, Eastern China, and Western Australia.[3] The insect has one to five generations per year, depending on climate. It overwinters as a mature larva in its cocoon spun in a crevice on or near the tree. In spring, moths fly a few weeks after pears bloom, mate and lay eggs singly on or near the fruit. The first instar larvae move to fruit and burrow into its pulp to feed. This pest originated in the Palearctic and has been in the United States for more than 200 years. Other important internal pear-fruit feeders include the pear codling moth (*Cydia pyrivora*), the Manchurian codling moth (*Cydia inopinata*), the peach fruit moth (*Carposina sasakii*), and the Oriental fruit moth (*Grapholita molesta*). The Asian species, *C. inopinata* and *C. sasakii*, are significant quarantine concerns for Europe, the Americas, and New Zealand.

Several species of Psyllidae (*Homoptera*) in the genus *Cacopsylla* are important pests of pears (see Table 1). Taxonomic status of the west Palearctic species of pear-feeding psysllids was clarified by Burckhardt and Hodkinson.[4] The North American representative, *C. pyricola*, is a European species introduced into the eastern United States in the early 1800s[5]; it now occurs in all pear growing regions of North America. Horton[5] summarized the biology of pear psylla in North America. The pest has two to five generations per year, depending upon latitude. Egglaying by the overwintered generation begins in late winter, well before foliage eggs appears. The eggs are deposited directly into the wood. Eggs of the summer generation are deposited into flower or leaf tissues. There are five nymphal instars. Beating trays are used to monitor adult psylla, while eggs and nymphs are monitored by taking spur, shoot, and leaf samples. Damage is caused by the feeding activities of nymphs. The nymphs produce large amounts of honeydew, and contact of this exudate with the fruit surface produces dark blotches or streaks, resulting in downgrading of the fruit. The damage is worsened by a sooty mold fungus that colonizes the honeydew and also marks the fruit. High densities of nymphs may additionally cause reductions in yield and fruit size.

Secondary pests include representatives from several arthropod groups, including leafrolling lepidoptera, mealybugs, aphids, a leaf curling midge, scale insects, and mites (see Table 1). Taxonomic composition of the leafroller complex varies regionally in North America, but the complex will commonly include the obliquebanded leafroller and an *Archips* species. The spider and rust mites are important secondary pests, and the rust mite especially can cause significant fruit damage and downgrading by its direct feeding on the fruit.

Keywords: Codling moth; Biological control; Chemical control; Leafrollers; Mating disruption; Pear psylla; Pears.

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Table 1 Major pest groups attacking pear

Type of Damage	Pests
Internal fruit feeders	Lepidoptera: Tortricidae
	Cydia pomonella (codling moth), *Cydia pyrivora** (pear codling moth), *Cydia inopinata** (Manchurian codling moth), *Grapholita molesta* (Oriental fruit moth), *Carposina sasakii** (peach fruit moth)
External fruit, leaf feeding	Lepidoptera: Tortricidae
	Archips rosanus (European leaf roller), *Archips argyrospila* (fruittree leafroller), *Archips podana* (large fruit-tree tortrix), *Pandemis pyrusana* (pandemis leafroller), *Pandemis heparana* (dark fruit-tree tortrix), *Adoxophyes orana** (summerfruit tortrix), *Choristoneura rosaceana* (obliquebanded leaf roller), *Argyrotaenia citrana* (orange tortrix), *Argyrotaenia velutinana* (redbanded leafroller), *Platynota stultana* (omnivorous leafroller), *Cacoecimorpha pronubana* (carnation tortrix), *Syndemis musculana* (autumn leafroller)
	Acari: Eriophyidae
	Epitrimerus pyri (pear rust mite)
	Acari: Tetranychidae
	Tetranychus urticae (two-spotted spider mite), *Panonychus ulmi* (European red mite)
Leaf feeders which damage fruit with their exudates	Homoptera: Psyllidae
	Cacopsylla pyricola, *Cacopsylla pyri**, *Cacopsylla pyrisuga**, *Cacopsylla bidens*
	Homoptera: Pseudococcidae
	Pseudococcus maritimus (grape mealybug)
	Homoptera: Aphididae
	Dysaphis plantaginea (rosy apple aphid), *Dysaphis piri** (pear bedstraw aphid)
Leaf damage; rarely fruit or flowers	Diptera: Cecidomyiidae
	Dasineura pyri (pear leaf curling midge)
	Acari: Eriophyidae
	Phytoptus pyri (pear leaf blister mite)
Damage stems and occasionally fruit	Homoptera: Diaspididae
	Diaspidiotus perniciosus (San Jose scale), *Diaspidiotus piri** (pear scale)
	Homoptera: Aphididae
	Eriosoma lanigerum (woolly apple aphid)

Many of these species also attack other pome, stone and small fruits. This list is far from exhaustive, especially for the leaf feeding pests. (*not found in the Americas.)

PEST CONTROL

Insecticidal Control

Insecticidal control of pests remains the standard for pear production in Europe and North America. The earliest sprays occur in late winter while the tree is still dormant, and consist of mineral oil often in combination with an insecticide. These sprays are directed at pear psylla, scale, and eggs of the European red mite. Subsequent pre-bloom sprays include oil supplemented with an insecticide directed at pear psylla. Early season control is critical for psylla management, as the pest shows explosive egg-laying potential during this period, and the natural enemies that attack psylla are generally not abundant enough at this time of year to control the pest.

Biorational alternatives for early season control of psylla include mineral oil sprays to interfere with oviposition, insect growth regulators to prevent egg hatch and for disrupting the molting process, and Surround (kaolin clay) to repel the adult psylla and interfere with oviposition. Kaolin may be applied several more times during the season, but is typically used one to three times up to bloom. At bloom, a second application of an insecticide or growth regulator may be used for psylla. Applications of abamectin or neonicotynl insecticides directed at pear psylla may be made following petal fall.

Table 2 Pear pests thought to be at least partially regulated by parasitoids, and genera of parasitoids responsible

Pest Group	Parasitoid Family and Genera
Pear psyllids	Encyrtidae: *Trechnites*, *Prionomitus*
Leafroller complex	Braconidae: *Apanteles*, *Oncophanes*, *Orgilus*, *Macrocentrus*, *Meteorus*, *Microgaster*
	Ichneumonidae: *Apophua*, *Diadegma*, *Glypta*, *Itoplectis*, *Triclistus*
	Eulophidae: *Colpoclypeus*, *Sympiesis*
	Tachinidae: *Actia*, *Nilea*, *Nemorilla*, *Pseudoperichaeta*
Scale insects	Aphelinidae: *Encarsia*, *Aphytis*
Mealybugs	Encyrtidae: *Acerophagus*, *Anagyrus*, *Leptomastix*
Aphids	Aphelinidae: *Aphelinus* Aphidiidae: *Aphidius*, *Ephedrus*, *Lysiphlebus*

Insecticide sprays for codling moth are implemented following petal fall, consisting generally of azinphos-methyl, phosmet, or a similar broad-spectrum insecticide. These products severely disrupt natural enemy populations. One or two additional sprays of broad spectrum insecticides may be used against the codling moth in its first flight, through June, and two or three additional sprays may be directed against its second and subsequent generations. Less disruptive chemicals, including neonicotinyls, growth regulators, and spinosad, may be substituted for the broad-spectrum products. A biopesticide, granulosis virus, is also used against the codling moth by some fruit growers, and may be an important component of the pest control program in organic orchards. Summer insecticide sprays for secondary pests such as leafrollers, mites, and mealybug are necessary in many orchards. These sprays may disrupt biological control.

Mating Disruption Control

Pheromone-based mating disruption of the codling moth represents an effective alternative or supplement to conventional insecticides for its control.[6] This approach consists of dispensing synthetically produced sex

Table 3 Common predatory arthropods in North American and European pear orchards (from[9,10] unpublished sampling studies)

Taxon	Family: Important Genera	Presumed Prey
Acari	Phytoseiidae: *Amblyseius*, *Neoseiulus*, *Typhlodromus*	Mites
	Stigmaeidae: *Zetzellia*	
	Anystidae: *Anystis*	
Dermaptera	Forficulidae: *Forficula*	Generalists
Heteroptera	Anthocoridae: *Anthocoris*, *Orius*	Mites, aphids, psyllids, mealybugs, eggs of Lepidoptera
	Miridae: *Campylomma*, *Campyloneura*, *Deraeocoris*, *Heterotoma*, *Orthotylus*, *Pilophorus*, *Phytocoris*	
	Nabidae: *Nabis*	
Thysanoptera	Aelothripidae: *Aelothrips*	Mites, thrips
	Thripidae: *Scolothrips*	
Neuroptera	Chrysopidae: *Chrysopa*, *Chrysoperla*	Aphids, psyllids, mealybugs
	Hemerobiidae: *Hemerobius*, *Micromus*, *Sympherobius*	
Diptera	Syrphidae Cecidomyiidae: *Aphidoletes*	Aphids
Coleoptera	Coccinellidae: *Adalia*, *Chilocorus*, *Coccinella*, *Cryptolaemus*, *Harmonia*, *Hippodamia*, *Scymnus*, *Stethorus*	Aphids, psyllids, mites, mealybugs, scale insects
	Carabidae	codling moth
Araneae		Generalists

pheromone at such a high rate or at enough point sources that the pheromone interferes with the males' ability to locate females. A formulation consisting of the main pheromone component, codlemone, together with some minor components, has been used successfully worldwide. Adequate control of the codling moth may require both mating disruption and insecticides, especially in settings where two or more generations of the moth occur. The use of mating disruption, in combination with selective insecticides, may allow substantial reduction of pesticide use.[7]

BIOLOGICAL CONTROL

Parasitoids

Many parasitoids attack pear pests and in some cases their activities help maintain low pest densities. The pest species that appear to be most affected by the activities of parasitoids are listed in Table 2, along with the parasitoids attacking these pests. Notable among these pests is the San Jose scale which is often heavily parasitized by the wasps *Encarsia perniciosi* and *Aphytis* spp. Parasitism coupled with dormant oil sprays often provides complete scale control in pears. Similarly, in the absence of disruptive insecticide sprays, the following pests may be heavily attacked by their associated parasitoids: pear psylla, especially by *Trechnites* spp.;[8] grape mealybug, especially by *Acerophagus*, *Anagyrus*; and *Leptomastix*. Leafrollers may also suffer significant parasitism from a large complex of parasitoids (see Table 2).

Predators

A taxonomic variety of mostly generalist predatory arthropods occurs in pear orchards (see Table 3). Important predators of pear psylla include especially several genera of true bugs, but also Coccinellidae, Chrysopidae, and Forficulidae. The codling moth is relatively safe from predators due to its feeding habits within the fruit, but adults may be susceptible to spiders, and large larvae in search of pupation sites and in their cocoons are vulnerable to ground beetles, spiders, and birds. The best summary and taxonomic list of predators in pear orchards is that by Solomon et al.[9] for European orchards. A similar review for North American orchards is long overdue. Quantitative estimates of impact by natural enemies attacking pests in pear orchards are mostly lacking. Much of the evidence available suggesting that predators contribute to biological control of pests in pear orchards is correlative, consisting primarily of observations that pest numbers decline in orchards having high populations of predators. There is considerable room for quantitative research on biological control in pear orchards.

CONCLUSIONS

Pear orchards support diverse communities of pest and beneficial arthropods. Pest control focuses especially upon managing an internal fruit feeder, the codling moth, often with use of broad-spectrum insecticides. These non-selective products are highly disruptive to natural enemies, leading often to problems caused by secondary pests, including pear psylla, mites, leafrollers, and mealybugs. The secondary pests, in turn, may require control using chemical sprays. Biorational approaches consisting of mating disruption for the codling moth coupled with narrow spectrum insecticides and biological control for secondary pests are being used. These selective approaches may be highly effective, but can be challenging to implement because of the need for intensive monitoring of the arthropod community, and the need for use of correctly timed insecticide applications.

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